

Advanced Data Mining and Deployment for Integrated Vehicle Health Management and the Space Vehicle Lifecycle

### Michigan Aerospace Corporation

#### Technical Abstract

In a successful Phase 1 project for NASA SBIR topic A1.05, "Data Mining for Integrated Vehicle Health Management," Michigan Aerospace Corporation (MAC) demonstrated its SPADE anomaly detection software to key personnel in NASA's Intelligent Systems Division (ISD) and with data from our partners at Boeing, SpaceX and GMV Space Systems. The feedback from these demonstrations was used to establish future development directions for Phase 2. Phase 2 will consist of three major efforts: 1) the design and implementation of the Taiga system, a next-generation enhancement of the SPADE software, 2) an investigation into combining complementary functionality of Taiga with existing code at ISD including the Inductive Modeling System, Mariana and others, and 3) the implementation of a prototype automatic parallelizer, in cooperation with subcontractor Optilite Solutions, for a subset of C++ useful for hardware acceleration of machine learning applications. The scope of the interaction with researchers in NASA ISD will be to explore the relationships between IMS and Taiga and gauge benefits such as Data Handling, Feature Reduction, Visualization and Explainability. We will also investigate heterogeneous ensemble methods by analyzing the Mariana system. Optilite's C++ Parallelizer will reduce MAC's development costs for parallelizing C++ code for multi-core chips and clusters. This effort will build on Optilite's existing body of work that supports graphical programming languages, and will extend their technology to the analysis and parallelization of C++ code. Both the Taiga system and Optilite's prototype have significant commercialization potential in industries as diverse as Chemical, Pharmaceutical, Manufacturing and Aerospace.

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Computational Model and Measurement Tool for Evaluating the Design of Flight Deck Technologies

### Aptima, Inc.

#### Technical Abstract

The runway safety issue has been on the Most Wanted list of the National Transportation Safety Board since the list's inception in 1990. The FAA has responded by implementing two ground surveillance technologies at major U.S. airports to reduce the risk of runway incursions. However, both technologies route information through air traffic control (rather than directly to pilots), which significantly delays safe responses. Several flight deck technologies that communicate information directly to pilots are currently in development. However, there is a need for tools to rapidly test the flight deck technologies early in the design process and measure their impact on pilot performance prior to implementation. We propose to develop two tools that can be used together or independently to evaluate performance of flight deck technologies aimed at improving runway safety. We will deliver a computational cognitive model (Adaptive Control of Thought-Runway Safety; ACT-RS) that realistically emulates pilot performance, thus reducing the need for human pilots early in the design process. In addition, we will deliver a measurement tool (Performance Measurement (PM) Engine) that can measure the impact of the flight deck technology on the performance of ACT-RS and a human pilot, making it useful across the technology lifecycle.

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